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AN INFORMAL STATUS REPORT  
ON THE  
ARMY RESEARCH AND DEVELOPMENT  
PROGRAM

BY

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Introduction

It is the purpose of this report to summarize my own personal opinions on the R&D Program of the Army as of mid-calendar 1966 to include:

- a. The organization of the Army to conduct research and development.
- b. The critical facility problems which need to be addressed.
- c. Those projects which need additional emphasis.
- d. Those projects which should be considered for cutbacks or termination.
- e. The status of individual line item programs.
- f. The general condition of research and development in specialized commodity areas.

It is my hope that this review can be helpful not only to introduce the program to the new Assistant Secretary for R&D, but also to provide him with at least some opinion as to what should be done next in order that continuity may be maintained until the staff has full opportunity to present their programs, thereby making it possible for him

to arrive at his own conclusions.

The report contains first a statement of the prime responsibility area most apparent to me during the last few years followed by some suggestions on organization, project emphasis, and facilities. Following these brief summaries there is a program assessment section covering each main specialty area under the headings which are used for budgetary purposes. The program breakdown illustrated by the charts has been helpful in describing the Army program to others. These charts have been used with continually updated program check points and constantly revised budget dollars in presentations to DOD agencies, Army Policy Council, Congressional Committees and Agencies such as IDA and the President's Science Advisory Committee.

### Prime Responsibility of the ASA(R&D)

The Secretary of the Army relies on his Assistant for R&D to see that the Army expenditures in R&D provide the materiel necessary for modernization and to see that the concepts made possible by scientific progress are introduced in order to keep the Army ahead of its potential enemies. This general responsibility is undoubtedly understood by any potential incumbent and I have found only active and eager support from within the Army Staff, the Army operating elements, and the rest of the Secretariat to fulfill this primary task.

Inherent in accomplishing the work is an unwritten responsibility which falls uniquely on this office. This is the responsibility for justifying to the Department of Defense almost all of the Army materiel requirements and, in many cases, the tactics involved in using the materiel (including, of course, the total amount of materiel required).

There are many within the Army and outside the Office of the Assistant Secretary for R&D who are officially responsible for the statement and justification of requirements and I don't suggest that there should be any change in these assigned responsibilities -- I only suggest that the Office of the Assistant Secretary of the Army for R&D supplies a very real, even if informal, link among



many Army agencies and the DOD agencies which must assess all programs. The DOD offices primarily involved are, of course, DDR&E and the Assistant Secretary for Systems Analysis. Both the Assistant Secretary for I&L and the Comptroller of DOD are also frequently interested in the same general question of requirements validity.

The Secretary of the Army is assisted in this critical area by Dr. Wilbur Payne, his Special Assistant for Operations Research and by a new organization which answers directly to the Secretary and the Chief of Staff, called Force Planning. This office is now headed by William Brehm and Brigadier General David S. Parker. In addition the Chief of Staff depends on ACSFOR and through that office, the Combat Development Command, for continually assessing present requirements and force definition as well as future concepts in tactics and force structure.

In spite of all these organizations, all of which earnestly try to look ahead, it falls upon the Assistant Secretary of the Army (R&D) to justify and rejustify new programs at the following stages:

1. Exploratory or advanced development. During this phase of the Army programs the pertinence to the Army of specialty areas may be questioned or there may be tri-service "roles and mission" problems which must be solved.

2. Pre-contract definition. Justification is frequently required in early concept formulation of a new weapon system.

3. Contract Definition. At this stage both DDR&E and Systems Analysis (DOD) will question the necessity and cost effectiveness of potential product and the effect such a product will have on Force Structure and the other Services.

4. Beginning of Engineering Development. It is at this stage that a real commitment is made and justification is necessary in a formal way to include advanced production engineering and trade offs with present equipment and strength.

5. Phase out of Engineering Development and Beginning of Production. This stage always involves questions again of how many, what will be replaced, has it become obsolete, does it now cost too much, etc. ?

Since only the developers or concept inventors really know the potential of new ideas and products, it falls on the Assistant Secretary of the Army (R&D) as their spokesman to see that this potential is properly evaluated and presented to the agencies which must insert the product into inventory, approve the expenditures for its development and production, and approve the force structure and tactics which are implied by its existence and proper use. One could easily

conclude from this most important responsibility that major re-organization within the Army was necessary or desirable. Existing organizations (ACSFOR, OPS, CDC, etc.) would argue vociferously and correctly that requirements formulation should not be left to the technical community and the inventors. Equally vociferous would be the analytical community who say with much validity that evaluation of new ideas and concepts must not be left to the inventors of new ideas since they are prejudiced.

Thus, though the requirements justification role is a very real one for the Assistant Secretary of the Army (R&D), it must, I believe, be an unofficial responsibility because otherwise parallel and unnecessary "Requirements" organizations would spring up throughout the Army requiring even more subtle coordination.

In this regard it seems obvious to me that the organization previously mentioned (Force Planning and Analysis Office) is an expedient to prevent a major shift in Force Planning responsibilities out of the Army and into DOD Systems Analysis. Its existence under these circumstances is of great importance but under any other environment it seems to me that this should be an ACSFOR responsibility. This opinion is offered because, as stated later, much work needs to be done in the early concept area of AMC and

CDC. During such developments the impact of this Force Planning Office, ACSFOR, and Dr. Payne will be important and it may become desirable to suggest simplification in the staff relations to AMC and CDC in the new concept area.

## Organizational Recommendations

Organizational changes in the Army R&D family that involve shutting down or combining installations are very difficult to make because of the road blocks which are set up by members of Congress. Thus, in general, reorganizations that move or shut down laboratories have to be approached one at a time in order that "homework" can be carefully done to defend such a move. Our attempts to shut down Springfield as an example have taken three years, and our justifications, I believe, were excellent. There are some changes that can be made however that do not involve moves of installations. I recommend the following:

### Advance Concepts Agency

In order to provide a creative group of scientists and engineers to work with CDC in developing new materiel requirements along with the tactics for their use, it is necessary, I believe, to develop a new and potent organization which can draw on all elements of AMC to create new concepts. I believe that this group should be located in AMC and answer directly to the Director of Research and Laboratories (DORL) for the following reasons:

1. AMC is the prime and only "Systems Inventor" in the Army and a competitive one should not be set up elsewhere. (It has been proposed to do this task in CDC or OCRD.)

2. If the organization is in AMC, it can draw on more specialized laboratories for talent, judgment, and their own creative ideas when necessary with minimum inter-organization problems.

3. AMC and particularly the DORL will have the maximum capability within the Army to evaluate the state-of-the-art and the related risks of alternate technical approaches to the problem.

4. By having a central creative and analytical organization the relative effectiveness of different approaches to new capability (missiles vs. guns, etc.) can be evaluated without built-in specialty bias which can happen if commodity commands to all the creative work in their own concept laboratories.

Because of the constant inter-relationship of this organization and the headquarters of CDC, and because it should be the "quick-response " system concept source for CDC investigations of alternate approaches to a requirement, it is my suggestion that the geographical location be at Ft. Belvoir. This recommendation is made in spite of the fact that the Systems Engineering group at the Ballistics Research Laboratory is probably the nucleous group of in-house



technical talent from which the new organization could be formed. In such a reorganization, the Systems Engineering Laboratory at the Ballistics Research Laboratory should definitely be made an inherent part of the resulting concept agency. In-house men who should be considered to head up such an agency include Harry Reed at MICOM, Dave Hardison at CDC, and I'm certain there are others. I would be pleased to offer other names from outside the Army if such an organization is created.

Analytical Aid to the Combat Development Command or ACSFOR

The requirements function within the Army has not matured, even though CDC and ACSFOR were specifically created to fulfill this function. This is not the responsibility of the ASA(R&D), but due to the fact that this office is the prime interface in the Army with Systems Analysis and DDR&E on any new product during at least three phases of development (pre-contract definition, contract definition, and beginning of engineering development), it falls on ASA(R&D) to provide justification not only for the product itself, but for the requirement that preceded it. Furthermore, when development is complete it falls upon the Office of the ASA(R&D), more often than not, to rejustify the requirement and help the Army to insert the new product logically into inventory. This implies effectiveness trade-off with older weapons, the decisions on how fast to introduce

the product, and how many new products should actually be introduced. Examples of such exercises are how many Cobras should replace UH-1B's; do you buy one-for-one Gama Goat for every 1-1/4 ton truck: can you use a new 5-ton truck for the 2-1/2 ton truck and economically cut down on types in the inventory?

This type of decision is made by ACSFOR and the analysis which should precede it is frequently not made or is poorly made. This void in the Army system has caused the Department of Defense to request a special organization temporarily being run by William Brehm and answering directly to the Chief of Staff. Its current prime responsibility is to determine the best size and make-up of the total Army (also an ACSFOR function), but its real reason for existence is to do, or have done, the analytical work necessary for Force decisions. Having noted this problem for some time, it seems clear to me that the real difficulty is that ACSFOR and CDC always seem to approach analysis problems with the thoroughness of a total military organization and all problems get the same total staff treatment regardless of priority or complexity. As a consequence, the study results are late, the analysis outline never cuts non-essential corners and interim results are difficult to come by. A group of excellent analysts answering to ACSFOR or CDC would provide eighty percent correct quick answers to many problems



most of which would suffice for even major decisions. This would then leave CDC free to fulfill deeper analytical problems on schedule without having a long backlog of high pressure efforts.

If such an organization could be created at CDC Headquarters, it could work closely with the Advance Concepts Agency just suggested for AMC and between the two a much clearer and more intelligent look could be taken of the future Army.

#### Communications and Control

DDR&E has recently seen fit to create an organization to review all programs in the tactical command and control area because of interservice conflicts and incompatibilities. Although I have serious reservations on this solution to our mutual problems, it illustrates the fact that we in the Army have not been as organized as we should be. The problems as I see them are:

1. ECOM should probably be the central lead laboratory, but it hasn't stepped up to the problem. It has the communications and avionics portions reasonably under control but little radar strength.

2. MICOM has a strong radar technology but no real desire to apply it to tactical problems, except in the specific areas of missile control.

3. AVLABS (MOCOM) has need for output from such a program, traffic control, tactical navigation, etc.

4. The Target Acquisition and Reconnaissance Laboratory needs navigation and positioning data.

5. Tactical Operations System (TOS) must somehow acquire information from multiple sources and present it to the field command level requiring it. (TOS experimental systems are being created by a special Seventh Army requirement task force.)

The pervasiveness of the problem is probably the reason no one (including myself) has really had a good suggestion on how to organize a development program to solve all the problems. It is, nevertheless, a very real problem. My only contribution is the feeling that an expanded ECOM, probably re-integrating the Satellite Ground Tracking organization (now living at Monmouth) and including major portions from MICOM, might be a good idea. This would involve adding to the facilities at ECOM which would appear to be nearly impossible for the next few years. Perhaps there are easier steps that escape me.

#### ACSFOR Studies Which Have Impact on R&D Organization

##### TOE Central Control (TOE = Table of Organization & Equipment)

In an effort to be sure that the field commands did not create TOE proposals that would change overall Force plans being developed

at the Pentagon it was decided that ACSFOR should have control of all Army personnel plans and TOE. This is a relatively new problem and I have not found out what the total impact is, but it appears that ACSFOR must now approve all laboratory personnel and equipment plans down to the detail normally covered by operational TOE. This doesn't make sense and was probably not intended by the policy but it should be looked at quickly before a "system" develops. AMC, with Director of Research and Laboratories, provides adequate control.

#### Test Plan Report

Another effort now being studied by the Army Staff is a plan for testing that started when the Vice Chief became concerned over persistent failures of the 175 mm gun in Viet Nam. This study now proposes removing the Test and Evaluation Command from AMC with many R&D implications. A report on the conclusions of this study should be obtained and a reaction to the Chief or the Secretary is in order along with support or modifications of the opinions now being developed by OCRD.

### Facility Needs

As I look back on the facility demands to fulfill R&D responsibilities these appear to me to be the most important. I have listed them in the priority I feel they should have.

1. Make some permanent home for the Harry Diamond Laboratory. My strong vote is for the Forest Glen location currently under the control of the Surgeon General. Secretary McNamara has turned us down once (I think his budget people were prime movers), but I have summarized our problem and history in a recent note to Dr. Foster requesting his concurrence on a resubmittal.

2. Expansion of facilities at ECOM to take care of current population and two potential new requirements:

- a. A lab for an expanded command and control function involving some experts from MICOM if such an organization can be developed.

- b. An expanded Night Vision Simulation Facility. This is a good concept and we should start it as soon as possible. Dr. Wiseman at ECOM knows of the proposal and can have it presented to you.

3. The Aviation Labs are well located for employees but facilities, such as they are, are needed for the Transportation

Command training programs. We have resisted successfully a move to Biggs Air Force Base in El Paso. General Besson would like to put the AVLABS with the Aviation Commodity Command at St. Louis, but I'm afraid we'll lose lots of good men. We lost eighteen to twenty-four during the Biggs move scare. In my opinion the lab should be moved to Moffet Field, Sunnyvale, California, but any move now would be awkward after turning down Biggs. NASA, Ames, is the location of an initial consolidation around an unused wing tunnel and Army activities at Ames include cooperative hiring of new men with NASA. It is the center of a sophisticated aerospace community and there may be space available which the Navy is not using due to curtailed activities on the base.

Concepts to Push (Hawkins' Opinion Only)

1. TOW on AAFSS.
2. Ground vehicle installation of M-5 type 40mm turrets.
3. Integral barrel 40mm ammunition.
4. Unique (not large area) application of incapacitants --  
silent mines. (See K. C. Emerson)
5. Mixed materiel in Army (particularly vehicles) where  
forward areas have special high-cost multi-capable  
devices--supported to the rear by modified commercial  
vehicles (cheap with minimum change for military).
6. Long Range LANCE (concentrating on conventional  
warhead).
7. Space bus multiple warhead for PERSHING.
8. Combined sensor with in-flight observers for reconnaissance (i. e., night vision, SLAR with MTI) and certainly COMMINT and ELINT sensors. This is probably  
a "behind FEBA" (Forward Edge of the Battle Area) aircraft  
sensor package with very low band width data transmission  
to ground. (Perhaps voice only.)
9. Ground sonobouys -- air or agent emplaced -- airframe  
could be a helicopter, perhaps -- (counting, sound, radar,  
or seismic?) The purpose here of course is to monitor  
enemy logistics and tactical moves.

10. Small arms development of flechettes for pistol-type weapons. This could make possible an extremely effective short range automatic or machine gun pistol.



Concepts to Close Down (Hawkins' Opinion Only)

1. SERGEANT Missile, then HONEST JOHN and LITTLE JOHN.
2. The 175 mm gun (Use LANCE and boosted round for 155 mm).



### Army R&D Programs

On the following pages are listed specific comments on the programming process itself and on the individual program line items. The format used consists of a bar chart that outlines the subject programs followed by my personal opinion of the status and the future prospects for the line item. In some cases suggestions are made for the future of the program.

These charts, kept up to date on a yearly basis, were used for presentations of the Army R&D program to a number of agencies including DOD agencies and Congress. On the following page is a listing of the major program categories that follow.

# FUNCTIONAL AREAS OF R & D

- FIREPOWER OTHER THAN MISSILES
- MISSILES
- COMMUNICATIONS-ELECTRONICS
- COMBAT SURVEILLANCE AND TARGET ACQUISITION
- MOBILITY
  - AIR
  - SURFACE
- COMBAT SUPPORT
- SATELLITES AND SPACE
- RESEARCH

### The Planning Cycle and Requirements

As I have reviewed the utility and work-ability of the planning system as described in the chart (page 3) I recognize the fact that the primary documents being prepared are in the nature of those that "good management" would dictate. This does not mean that they are useful and I suggest that major revisions take place so that the very considerable effort being made to produce these documents be re-directed to more useful pursuits. Specifically:

Army Research and Development Long Range Plan (ARDLRP) and the Army Research Plan (ARP) contain a sort of compilation developed from the Technological Forecast prepared by the Army Research Office (ARO). There is no document or official dialogue that takes place between the Combat Developments Command (CDC, the Army Materiel Command (AMC), and the Office, Chief of Research and Development (OCD) to produce the Army Research and Development Plan and there should be. Some of the problem here is that CDC does not have sufficient technical staff at headquarters to contribute to such a dialogue and AMC has no "Systems Concept" team or organization which concentrates on thinking creatively about potential solutions to requirements. Thus it becomes a responsibility of OCD to attempt some sort of long range conjecture or plan to serve as a guide to those parts of the

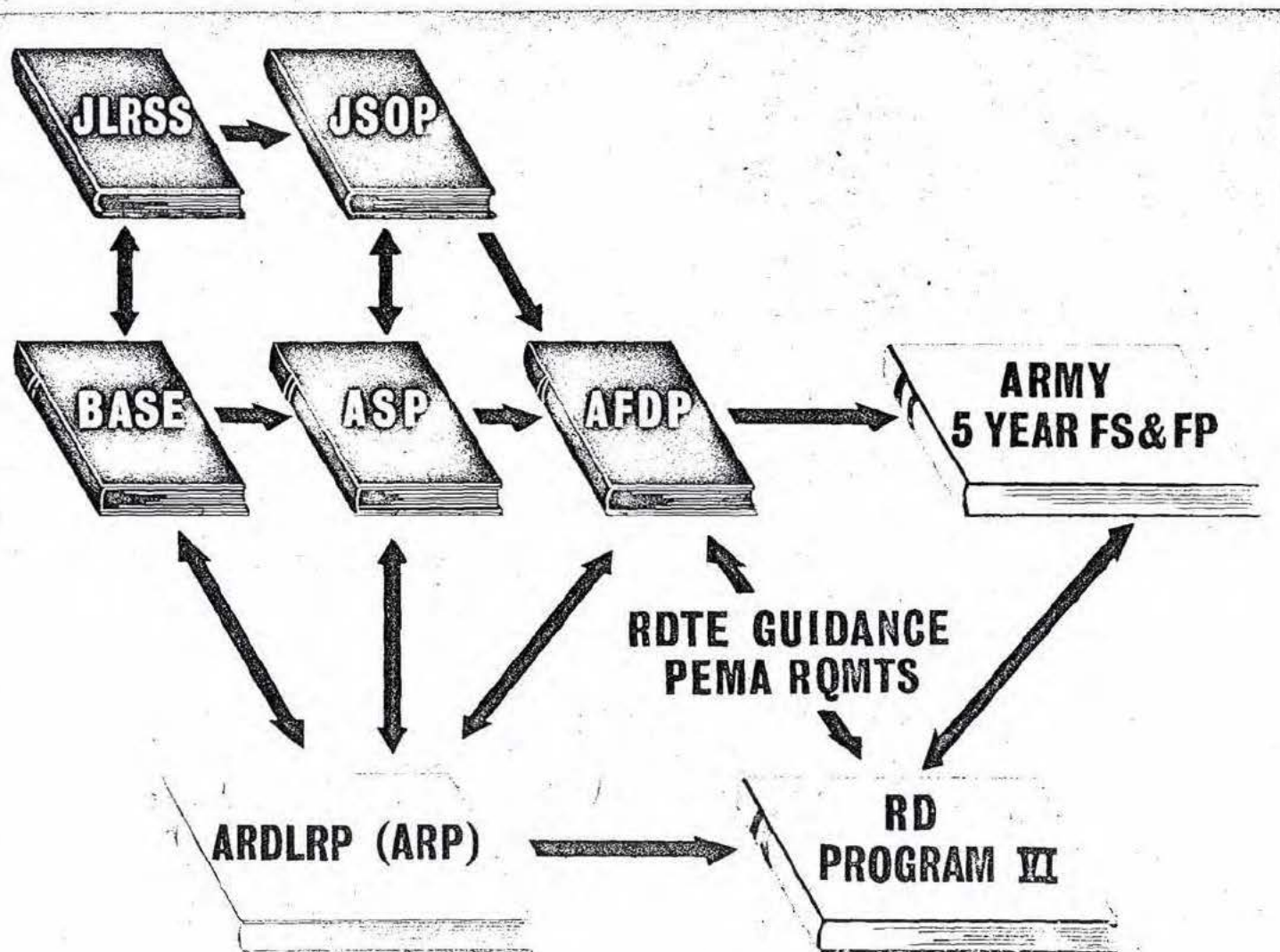


FIGURE 11



Army that need guidance. I doubt if the more aggressive laboratories pay much attention to any of these documents, since they have their own plans for the future which they don't articulate to the outside world except through their request for budget at the time of programming each new year's efforts.

I have suggested a new organization in AMC called a Systems Concept Agency (my suggestion is that it should answer to the Director of Laboratories at AMC) and that a similar overall study planning organization be created in CDC. A task force of these two organizations perhaps chairmanned by OCRD, could very well complete an Army Long Range Research and Development plan - updated each year and reviewed by a board of in-house scientists from both CDC and AMC with additions from OCRD. This would correspond to an expanded Ad Hoc organization similar to The Army Research Council, TARC. (Dr. K. C. Emerson or Dr. Siu at AMC can contribute a complete description of TARC).

By such a procedure we could create an Army Research and Development Plan with no supporting or specialist studies. I believe that the compilation of this one document would weld OCRD, AMC, and CDC once a year and that the document would be vital and of use to the Army Staff. Furthermore the preparation would be sufficient to get CDC, AMC, and OCRD all talking the same

language early in the formulation of future plans. Eliminated by this process would be the preparation of the ARP and the Technological Forecast reports.

Tasks yet to do:

1. Create the Advanced Concepts organization in AMC.
2. Create a similar senior analytical advanced Studies Organization in CDC.
3. Formalize the process of preparing a once a year ARDLP to supplant all the other documents. (This should probably be sponsored by OCRD and the report prepared by them annually and approved by an Ad Hoc group similar to TARC augmented by CDC top-level participation.)

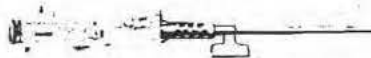


# FIREPOWER OTHER THAN MISSILES

M1, M14, M79, AR 15



Cal. 50 MG, M2, & M85



ENTAC, 106mm RIFLE



M41 TANK 76mm GUN  
90mm SP GUN



65 66 67 68 69 70 71 72 73 74

INDIVIDUAL WEAPONS

VEHICLE MOUNTED AUTOMATIC WEAPONS

COMPANY & BATTALION ANTI-TANK WEAPONS

TANK WEAPONS

FY 66 R&D FUNDS (THOUSANDS)

SPECIAL PURPOSE  
INDIVIDUAL WEAPONS



6,649

VEHICLE RAPID FIRE  
WEAPON SYSTEM



2,848

HEAVY ASSAULT  
WEAPON (TOW)



17,100

SHILLELAGH



4,550

▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION △ PHASE IN PHASE OUT OF INVENTORY

FIGURE III

## Fire Power other than Missiles:

### Individual Weapons:

As I look at the only fully developed program, the SPIW, I find a singular lack of reasonably new ideas and a strong desire for some. Although the SPIW suggests a better effectiveness by means of the dispersed pattern of three flechettes, the other characteristics of the ammunition may diminish its value: the problem of tracers, the slug effect (penetration of deflecting foliage, etc.), the cost of ammunition, the applicability in a machine gun of the flechette ammunition against light vehicles, etc. The study program now in being (Small Arms Weapon System - SAWS) may lead to a better solution than the M-16 with a "clip-on" one-shot 40mm grenade launcher, but at this writing this looks like a reasonably optimum solution. This solution does not have a machine gun or carbine or pistol member of the family.

The SAWS Study is evaluating weapons and weapon concepts in which common mechanical elements can be put together to make a family of weapons. The M-14 rifle has a machine gun counterpart, has tracers, and is preferred by the Army except for Viet Nam type of operations. It is my opinion that a family of new weapons may emerge from SAWS but that it will have hard going to replace the M-14 or M-16. Rather than change I would recommend harder



efforts at flechette small arms ammunition reducing kick and permitting hand held pistols with high kill probability at short range. Flechettes might be good for a sort of machine gun pistol again used for short range combat.

#### Vehicle Rapid Fire System

A new system may also evolve from current studies but again there will be a lot of "opinion" in any new development. Current leading contender is the TRW 25mm gun. It is a proprietary weapon and we have two ordered for test. It uses Swiss Ammunition (the manufacturing rights are secured by TRW). Unless the new study VRFWS turns up a new idea, which I doubt, this is the only development now apparent which is worth supporting.

A companion and perhaps primary weapon for vehicles is a version of the 40mm grenade launcher M-5 designed for helicopters. This, I believe, will prove to be very lethal and may be suitable for most vehicles since it is lighter, better against "manpower", and has a substantial armor kill capability within its range.

It should be noted that the Army needed to upgun its reconnaissance vehicle (M-114) and had to buy HS 820 guns from the FRG for retrofit on this vehicle. This gun, is now in good shape but is not as simple as it could be and should not be specified for any other use unless a major re-evaluation confirms such a decision.

### Tank and Anti-Tank Weapons

There are two basic ranges of guided anti-tank weapons, and there may be three, depending on whether it is finally determined that effectiveness is sufficiently improved to incorporate guidance of a sort on the Light Weapon (LAW). I believe that the idea of D.C. guidance on the LAW via a thrust floated gyro (if it can be miniaturized enough and made cheap enough) would help kill probability at ranges out to 300 yards and that this might be more cost effective than the simple aimed fin stabilized LAW we now have.

The MAW (being developed by McDonnell) should be OK for 300-750 yards and from there up to 3000 yards the TOW should be OK for some time to come. TOW, incidentally, should be attached to any or all helicopters with any hardpoint attack problems including tanks. With the Hughes sight now starting development this combination may make tanks pretty vulnerable.

For the longer range\* Anti-Tank problem (1000-3000 and beyond) it is reasonably obvious that we need a "shoot and scoot" concept. An interim concept is the laser illuminated target system with the missile seeker homing on the reflection. This should be supported because it has the capability for indirect fire against targets illumination by forward observer. Another concept is the contrast seeker or area integrator which "sees" an object passively. If this can be developed it may be the best hope for the future but

\*Meaning 1975-1980



before anything of a major nature is planned, it should be determined that camouflage of a simple nature won't defeat it. This type of weapon is the only potential replacement for Shillelagh and it should not be necessary before the Shillelagh has gone through another development phase to make it capable of being fired with a passive night sight.



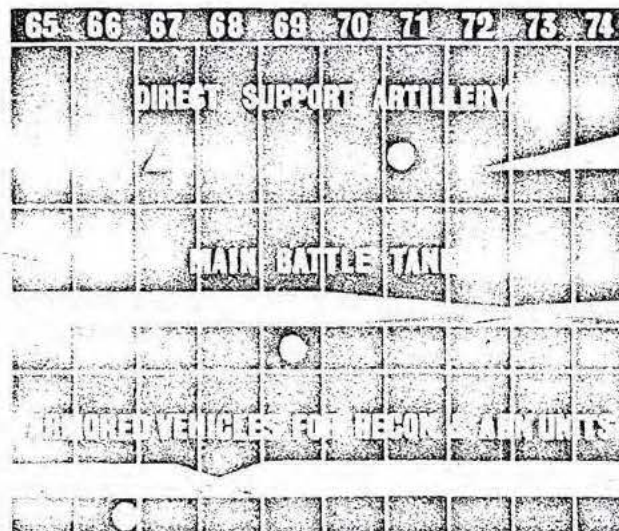
# FIREPOWER OTHER THAN MISSILES

NEW CAPABILITY

M-48, M-60



M-41, M-56



FY 66 R&D FUNDS (THOUSANDS)

AERIAL ARTILLERY WEAPON



2,000

MAIN BATTLE TANK 70



23,176

ARMORED RECON / ABN ASSAULT VEH (SHERIDAN)



500

▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION ▲ PHASE IN PHASE OUT OF INVENTORY

FIGURE IV

## Firepower other than Missiles

### Direct Support Artillery

The artillery R&D activity is notable in its lack of specific programs. This has been of some concern to me and it could probably stand a hard look by a panel from the Army Scientific Advisory Panel (ASAP). My suggestions would be:

1. We try to get boosted AMMO for all our tubes 155, 105, 152 and perhaps 90mm, thereby reducing tube weight or increasing range, whichever seems most profitable.
2. For indirect fire we try a terminal guided shell using forward observer laser illumination on the target.
3. An area coverage system like the MARS which we are studying in parallel with the FRG. My instinct is that our guided rounds as now conceived are too large. We should have rounds small enough for a two-to-three round simple jeep launcher as well as a larger launcher with many more rounds.
4. Viet Nam showed us the importance of moving artillery to new positions by helicopter. There may be an



(anchored) easily in remote locations - wherever the helicopter could deliver it. We need to know whether this is or should be an artillery piece - a small missile (MARS?) - or a mortar.

5. Mortars should also be looked at with two-stage propulsion systems for longer range. If we put some thought on it we might be able to take tube artillery out of the inventory for Air Mobile operations.

#### Main Battle Tank

The MBT-70 program with the FRG has achieved firm definition and a reasonable development program has been defined. The Army should stick firmly to the program and the firepower combination (SHILLELAGH, discarding sabot penetrator, and conventional round combination in one tube). The only future change that I recommend is the inclusion of the turbine engine as soon as its development reaches the proper stage - in fact, I'd install it too soon rather than later. We'll never solve all the problems until it is scheduled to go into inventory. The risk will not be large in my opinion.

The MBT-70 may be the last tank if we cannot find a counter to the TOW-equipped helicopter. There is no "MBT-defense" program against aircraft or helicopters and there probably should be such a program if any new ideas appear to have promise.

The MBT program is now the subject of a concentrated attack by Systems Analysis. It is apparently their conviction that the analysis of the effectiveness of the tank is biased, the technical risk is unacceptable and the costs are either unknown or too high. Keeping the tank program on schedule and successful with all this help will be quite a task. It is my conviction that we should proceed as planned. This will be the only tank system designed all at once that anyone can remember.

#### Armored Reconnaissance Vehicles

The SHERIDAN looks like a good concept and won't need replacement very soon. I believe, however, that this requirement is a good one on which to try new concepts just as it was used to introduce the SHILLELAGH. Thus, I'd suggest the following for the future:

1. We ought to be able to use rubber for tracks - not steel and aluminum. This should make the vehicle lighter and extend the replacement cycle.
2. We should be able to install a regenerative version of the LOH turbine engine.
3. New - removable armor should be a part of the concept so that the amount (if any) of armor could be adjusted to fit various theaters or missions. This also permits use of "breakable" armor which needs frequent replacement.



# MISSILES

HONEST JOHN  
LITTLE JOHN



NEW CAPABILITY

HERCULES, HAWK-ATBM/  
HIP

0 11,300



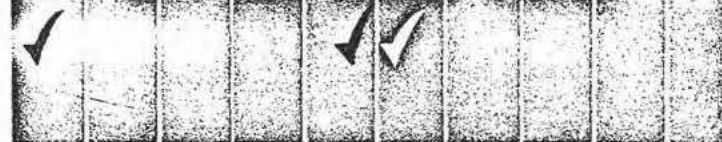
NEW CAPABILITY

65 66 67 68 69 70 71 72 73 74

CORPS & DIVISION SUPPORT WEAPON



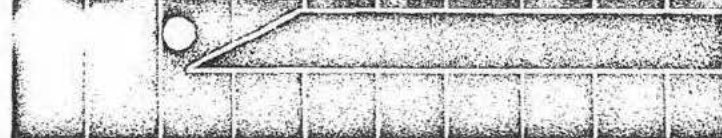
ANTI-ICBM DEFENSE SYSTEM



FIELD ARMY AIR DEFENSE SYSTEM



MAN-PORTABLE AIR DEFENSE WEAPONS



FY 66 R&D FUNDS (THOUSANDS)

LANCE



46,000

NIKE X



390,000

SAM-D



15,000

REDEYE



3,500

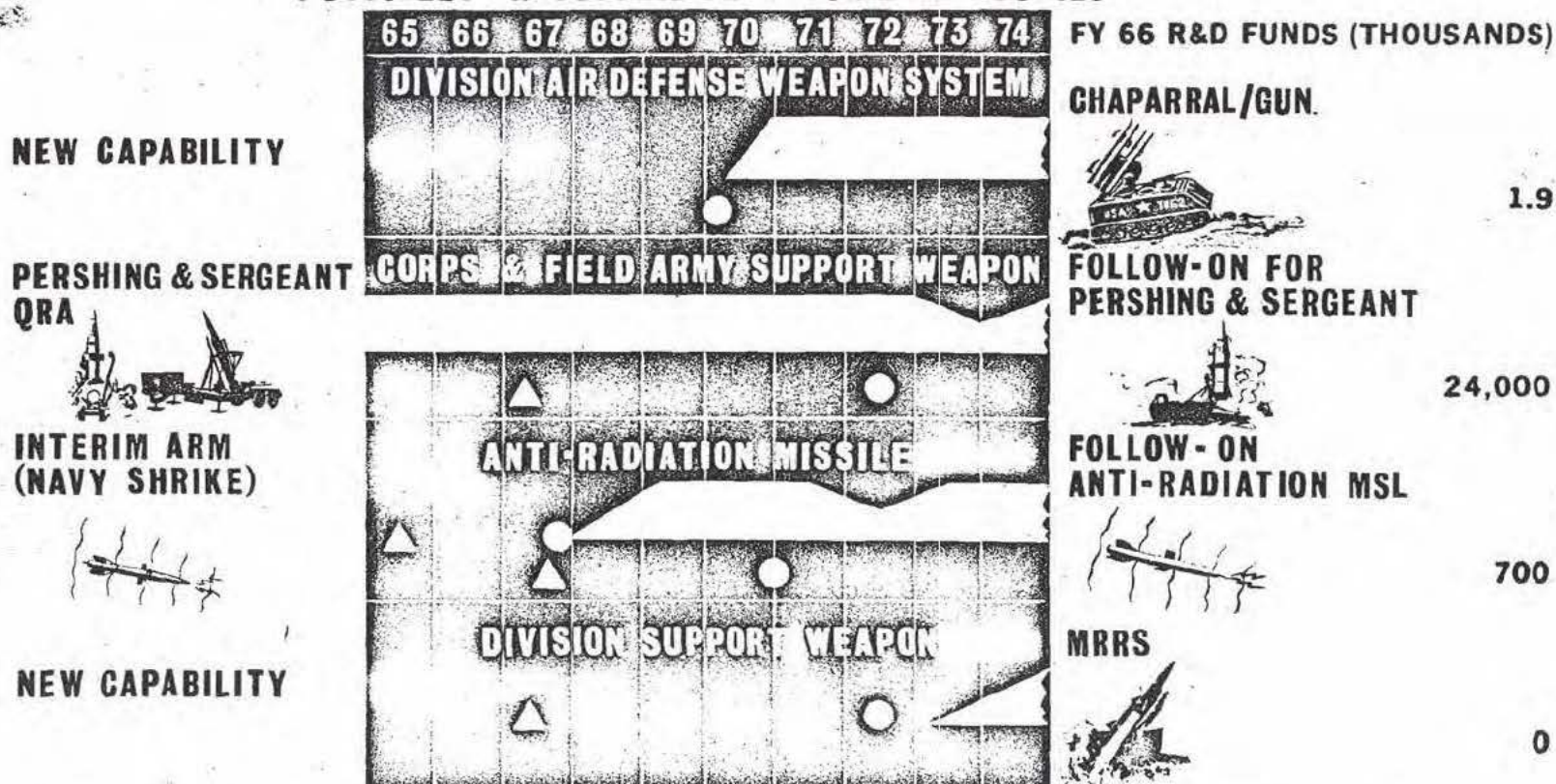
▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION ▲ PHASE-IN/PHASE-OUT INVENTORY

FIGURE V



# MISSILES (cont'd)

"POSSIBLES" RESULTING FROM CURRENT STUDIES



▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION ▲ PHASE IN PHASE OUT OF INVENTORY

FIGURE VI

## Missiles

### Corps and Division Support Weapon

The LANCE concept guidance, I believe, is good and for the present LANCE range of approximately 40-60 km it should be an excellent weapon with conventional warhead. At our present state of "political" development it will be necessary to keep LANCE useful and justifiable with a conventional warhead. This should be possible even for extended ranges if a consistent one-three mils accuracy is achieved for deployed missiles (hopefully closer to one mil).

As a nuclear weapon the LANCE guidance could probably be used at ranges beyond extended range LANCE, and it is my opinion that the LANCE can be further developed to cover the SERGEANT mission. This program should be started as soon as possible after the current long range LANCE studies are completed at AMC. This use of LANCE would make possible the curtailment of an expensive SERGEANT product improvement program being proposed for 1968 and subsequent years.

The TRW firm in Los Angeles is experimenting with a plated copper or nickle ballonet for expulsion of stored liquid propellants. This should be investigated for LANCE along with constant attention to solid propulsion advances to see if follow-on LANCE could have simpler propellant systems.

The potential of a low cost Missile System as pioneered by LANCE suggests that a Jr. LANCE might be possible to parallel the 175 mm gun or replace it. This would be a similar device to the MARS previously mentioned and it would be competitive with the extended range (boosted) 155 mm gun. Nevertheless I feel that there may be a useful concept here and it should be investigated.

#### Anti-ICBM - NIKE X

This year should have been the year to decide on deployment but the cost of Vietnam and vague fears of reaction internationally caused it to be delayed again. During the calendar year 1966 we are scheduled to study many elements of the system in a variety of roles including hard point defense, NATO, Japanese, and total U. S. deployment. I believe we should try to concentrate on hard point defense studies and propose an initial defense deployment around the most likely configuration of MINUTEMAN silos to be retained in any subsequent ICBM improvement program. This deployment plus the VHF net would give us a chance to put all elements of a potential National system together so that further deployment costs and lead times could be more easily determined. One thing also must be done and that is to study once more what ARPA and IDA have learned or contemplated in cheaper radars - different approaches to computing and in high acceleration missiles. If we see no changes that need to be made and if



we are delayed again in 1968 its time to cut back on R&D. We can't justify going on forever at 400+ million a year if we aren't going to use the effort. To deploy we must decide that:

1. NIKE X deployed does not destabilize our deterrent posture internationally.

2. The program can be sole sourced in spite of Congressional - GAO pressures.

3. There isn't a better concept just around the corner.

To do a good job of No. 3 we need an assistant to Colonel Drewry who would eventually be the technical director for the total system. This man should be given the first priority task of deciding when and how the NIKE should be changed to permit major advances in the state of the art to be incorporated. He will, of course, need an advanced concepts organization and may have to let some experimental contracts. I believe this organization should take over the ARPA DEFENDER activities.

#### Other Ground to Air Defense Weapons

The SAM-D system is a final compromise concept that permits maximum state of art improvements to be combined in a mobile system concept designed to defend an area against F-111 type aircraft and self defense against 650 nautical mile tactical weapons. This is

at least the Army's fourth attempt to get to the Contractor Definition Phase. The last of the perturbations involved forced commonality between the Navy's task force defense concepts using separate search and track radars and the Army's forward area defense concepts. The CDP competition involved an expansion from two contractors (Army) to approximately seven more performing under present Navy studies. We may get a CDP going soon unless current overtures between FRG and U. S. turn this into a joint international program.

If this happens we may get a system before it gets obsolete but I doubt it. In short so many people have helped with SAM-D that it is going to be difficult even with the best of intentions to get a definition to stay put long enough for a rational program. My effort has been to try and find the simplest possible concept that will permit a single radar element, (as distinct from separate search and target track units) an advanced missile, and a quick response computer system that can handle at least 8-12 engagements at a time. I hope that the whole system can be new so that future modifications of the elements will have some modern building blocks. There is great and persistent pressure to build onto the HAWK system and in my opinion this is false economy. Our HAWK improvement programs have literally created a new system already and it is obsolete before its development is over.



### Proliferation Systems

Out of our quandry over forward area defense systems (Note SAM-D above and MAULER cancellation because it couldn't handle multiple targets) we moved almost in desperation to a proliferation concept that we should have reached earlier. This concept suggests that the most effective defense consists of many "clear air" defense weapons that are cheap and can be distributed over a wide area supplemented by fewer, more capable, all weather systems which can handle the fewer "all weather" targets. This optimization process is far from complete but we have at least created the clear air systems that had been ignored before. They are:

1. REDEYE: An unusually good concept that can be used by an individual permitting defense of isolated important units which are rarely vulnerable to very fast aircraft (because they cannot be found by such attackers) but which are vulnerable to the slower searchers for targets of opportunity. Small units need this defense. This system should continue into operation in spite of some limitations so that we learn what operational problems develop. This will require some resistance to internal pressures for immediate performance improvement. In my opinion the improvements, if any, should be in reliability, quicker reaction, lighter weapon, and lower cost. I suggest

that improved performance, faster targets, longer range, greater lethality will shortly lead to a heavier system requiring a vehicle and we will then have lost the infantry man's defense.

2. CHAPARRAL: This, to me, is the proper weapon to improve in performance so that it has more capability against head-on targets. In its present form it is not a good point defense weapon but it is the weapon that can charge admission for passage and will drive the targets up in altitude where other weapons can be brought to bear. With capability for head-on attack it can supplement guns at important "defense" points.

3. 20mm Gatling Gun: This is our only head-on point defense system and must be retained for this mission and improved through the years. It needs to be combined with a better fire control system and a warning net. As a gun there is little I have to suggest in the way of improvement.

#### Other Defense Concepts

All of the systems discussed have been selected in the presence of such ideas as the TV guided weapon (British ET-316), versions of TOW-like weapons, and the persistent suggestion that focusing the



warhead will improve effectiveness of the more sophisticated systems. Three ideas in this general field appeal to me and might merit increased exploratory research support.

1. Command Mid-course Guidance plus Complete

Self-contained Terminal Homing: This could take the form of quite accurate mid-course with focused warhead as the terminal phase. It might also take the form of "all weather" mid-course and a sort of clear air (IR) terminal phase that would be effective in most "all weather" situations (through overcasts etc.).

2. The Flechette Warhead: In the artillery programs

the Army has been developing a munitions concept for anti-personnel use that may have application for anti-aircraft systems. The lethal part of the shell consists of many stable flechettes which are fused to deploy in a cloud of small but still high velocity elements. This in effect changes the lethal volume from a conventional sphere to a tube with substantial residual velocity. What the minimum size caliber should be and which fuzing system to use are questions as yet unanswered and no program now exists. I suggest that there should be one.

3. For "all weather" defense it is obvious that the target will be highly instrumented and it may be that an anti-radiation defense system would be effective - anti-terrain

avoidance radar or anti-airborne search radar. This concept should be investigated thoroughly to see if a signature that is simple to home on is readily available.

### SERGEANT

In discussing LANCE I suggested that it should be improved immediately to take over the SERGEANT mission thereby saving the large expenditures for SERGEANT improvement. This improvement program will help the credibility of the ground test gear and the confidence in the test gear but it still won't make the system less complex nor will it improve its mobility and manpower requirements. We should get rid of SERGEANT as soon as LANCE can be stretched to take its place. In my opinion we should retire SERGEANT even sooner since the present LANCE and the PERSHING pretty well cover the real requirements.

### PERSHING

Last year we had a searching analysis of the PERSHING future. It resulted in a major program for updating the ground equipment so that reaction time was reduced, and quicker repeat firings could be made. This QRA (Quick Reaction) program is sound and the development of wheeled launcher carriers fits into this expanded (semi-strategic) use of PERSHING for specific predesignated targets.



Also started was a small research program to extend the range of PERSHING. No one could agree (DDR&E or Systems Analysis) whether this was necessary or, if so, how far we should go. The Army recommendation finally prevailed and we have funded some advanced developments which should lead to a potential third stage motor, a reentry body size guidance system and a variety of pen aid systems. For a minimum size warhead (nuclear) an 1100 - 1400 mile range should be achievable but of more importance the Army would have the elements of a multiple warhead system with guidance aboard to distribute these warheads accurately over a substantial area. Next year these programs will need to be guided into a total system probably via a new CDP for a third stage. Our homework on what the performance parameters should be should start now with discussions among CDC, ACSFOR, Systems Analysis and DDR&E. A three warhead bus system is now in the Staff and should be encouraged, I believe.

#### ANTI-RADIATION MISSILES

The Navy already has SHRIKE and we have declined to support this development with Army funds on the basis that this is an air launched weapon and should be handled either by the Air Force or Navy. We have looked at a ground launched version of this but I have not supported this concept since I believe the aircraft launched

version is much more useful, flexible, wider ranging and does not require specialized troops for this isolated mission.

We should experiment in the seeker techniques because, as noted previously, there may be a possibility of using anti-radiation homing in an air defense all weather weapon.

#### MARS: Multiple Artillery Rocket Systems

These systems have been discussed previously under the Artillery heading and they appear to have a major advantage over tube artillery in weight of launchers, and long range accuracy (if they contain rudimentary guidance). They appear to demand large area targets however and therefore they run into competition with LANCE. The right compromise may be a boosted artillery round with some DG or Automet guidance at small size (155 mm) or we may find a Jr. LANCE worth considering.



# COMMUNICATIONS = ELECTRONICS

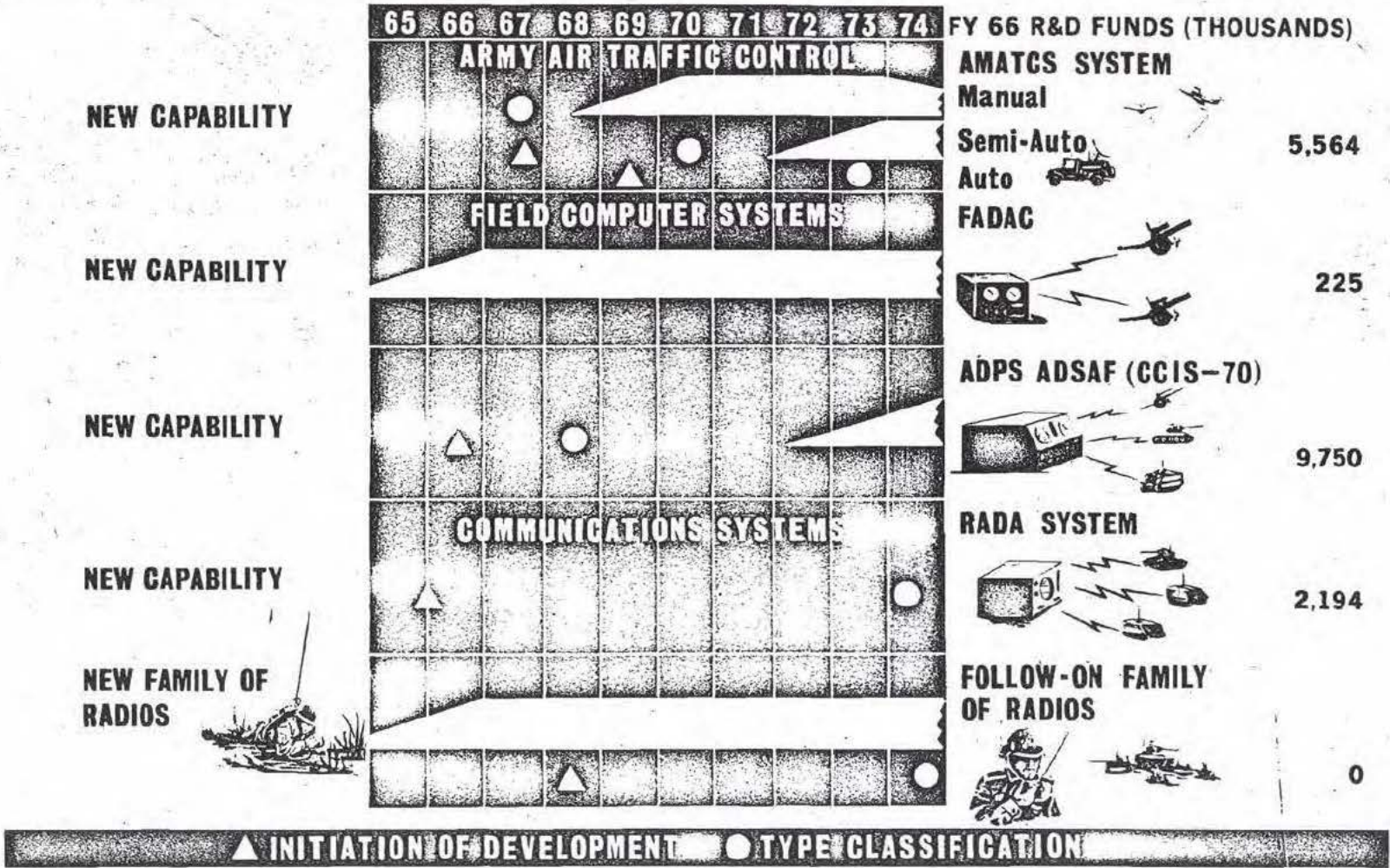


FIGURE VII



## Communications and Electronics

### Army Air Traffic Control

System development in this area is inevitably going to run into interservice problems and I believe we should carefully review our requirements to see that we are working in areas not covered by the Air Force or Navy (Marines) and that we are reaching far enough into new state-of-the-art to get low volume and high reliability. Specifically we should go as far into microcircuitry as we possibly can. It is suggested that our traffic control systems be limited first to very local terminal control fully capable of being implanted randomly in areas served by air mobile units. We should also spend more time on simple "get home" navigation systems to reduce costs. The get home capability should rely on the terminal system for final guidance to the terminal thereby relieving the airborne elements of major long duration accuracy requirements.

### FADAC

The FADAC is a reasonable first step in the tactical use of computers but it suffers in reliability because of its state-of-the-art (old concepts). It is at once an element of a field army automatic data system and a unique element in a more local "closed loop" artillery system. We should move as soon as possible into the



next generation FADAC aiming at less, rather than more, functions and aiming at cigar box rather than trunk size volume. The Litton Company has pointed out that our expressed policy of throwing away plug-in elements has forced development into the place where the connectors, not the elements, are the items that are failing. By trying to keep plug-in elements so cheap that we can throw them away we have driven the size of the elements too far down. They say we should have more complex large elements (minimum interconnect problems) more spares, and we should repair at some distance from the use area or in CONUS rather than throw them away. I tend to agree with their suggestion. Their computer (304) has only 1/2 dozen plug-in elements but if done the Mil. Std. way it would have 27 times more volume and substantially less reliability.

ADSAF: Automatic Data Processing System for the Army in the Field

This system has had an extremely spotty history because there were no clear requirements and in our enthusiasm to do everything by computers we created a monstrous system concept that could never be made to work, would not have had any mobility, and would have made any Army or military elements extremely vulnerable if it had been fully depended upon. As a consequence Dr. Fubini stopped all activities and granted 5 million per year for 4 years if we would turn this money



over to the 7th Army and let them, by means of experimental systems, define the requirements. This has become known as the 7th Army experiment and is the cornerstone in the development of any Tactical Operations System (TOS).

A major element of such a system is the TACFIRE, including the previously discussed FADAC and some kind of intelligence collection system. The TOS does not include the logistics systems for which extra developmental money is required. The use of an operational element of the Army to develop requirements, and do the necessary tests, bypasses both CDC and AMC and there has been substantial resistance to the move within the Army. ACSFOR has been consistent in trying to control all of the money spent within the U. S. on the experiment, leaving only the European expenditures under the control of 7th Army. I have had to intervene several times to place this responsibility firmly in 7th Army and to see that they were supported wholeheartedly by AMC and ACSFOR elements as well as CDC. This has had the effect of gradually cancelling a major contract effort at Fort Huachuca (Bunker Ramo Corporation) and we may not have developed enough talent in 7th Army (also supported by Bunker Ramo) to really create anything. In short, this effort will require constant pressure by someone who understands the computer business to get to a conclusion. Howard Gates has been doing this

from the ASA(R&D) office as time permits.

RADA: Random Access Discrete Address System.

This concept appears to offer advantages in providing a high capacity communications system to field commanders which will free them from wires and immobile communications centers. It has come under attack from DDR&E as too ambitious and too far ahead of the state of the art. They also suggest that two Army elements operating across each other will result in either jamming or diverting calls. Finally, they fear that it can never be miniaturized enough to be practical. All these problems are, of course, minimized by the contractor. The support is now adequate to do the first elementary tests in the field. As soon as there is any basis for real optimism we should press harder for added support.

Other Communications Activities

In this area my major concern is that we have not looked at compatibility among ground-to-ground, vehicle-to-vehicle, vehicle-or ground-to-air, and air-to-air systems to be sure that we have the communications to go with the developing flexibility of the Army in the field. Perhaps there is no foundation for this concern but it seems to me that each new set or subsystem reaches for more channels (hence more cost) rather than less channels which would permit



smaller and smaller sets and lower power with large improvements in reliability. The requirements continually demand more capacity which I doubt is justified. Finally, I am certain that voice communication is not necessary for a major part of our communication problems and rather than put in teletypewriters in forward areas we might well consider a reduced alphabet code book that did a "Morse type" communication job with narrow band compressed messages. Nobody is working on this that I have found.



CONFIDENTIAL

# COMBAT SURVEILLANCE & TARGET ACQUISITION

NEW CAPABILITY

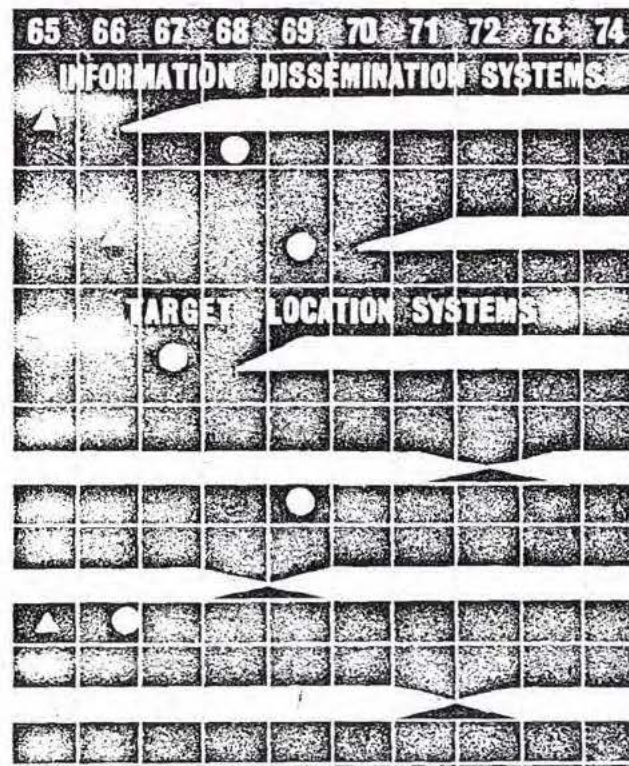
NEW CAPABILITY

NEW CAPABILITY

AN/MPQ-10

AN/PPS-4

AN/MPQ-4A



FY 66 R&D FUNDS (THOUSANDS)

TIIF



900

DATA TRANSFER SYSTEM



1,052

VATLS



2,400

COUNTER BATTERY RADAR



1,150

LT. WT. SURV. RADAR



75

LT. WT. HOSTILE MORTAR LOCATOR RADAR



1,000

CONFIDENTIAL

▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION ▼ PHASE-IN/PHASE-OUT OF INVENTORY

FIGURE VIII



## Combat Surveillance and Target Acquisition

This is my candidate for the most important and probably most difficult area in which contributions are needed. History records a combination of many ingenious ideas of data collection with little or no concept of how to correlate the data - present it - or to whom it should be presented. In spite of this much money has been spent in futile data correlation and presentation schemes all of which have fallen of their own weight. My contributions have, I'm afraid, been mostly negative. I have not supported a new reconnaissance airplane (STAAS) and I have relegated an artillery radar to test status only. I have tried to get a real review of requirements instigated and the first several efforts were miserable (though diligent) collections of everyone's idea of what total information they wanted. The very volume developed presages an impossible system concept. The present effort is the TARS 70 study now at Leavenworth, due in December '66. If this report finally gives a clue to:

1. How we can give surveillance and target information to lower echelons in simple forms with minimum detail or,
2. How we can tie information more tightly to the immediate response element or weapon as in forward area observers for artillery or,
3. How we can find out how to use correlated informa-



tion without going up to high command echelons (comparing Elint, I.R., photo, and radar at Army or Corps level reconnaissance centers) ----- then, perhaps, we have a start.

I have high hopes (and I'm nearly the only one) for the VATLS System (Visual Airborne Target Locator System). This system is a telescope mounted on an inertial platform with a North heading reference. In concept the observer points the telescope, gets a range via a coaxial laser and transmits to the ground only target description (hopefully with only a few words or code) while the system transmits range, elevation, and direction from the platform along with platform altitudes. The platform location is determined by ground-based elements using tracking (radar). This system can be operated behind the zone of combat overlooking the Forward Edge of the Battle Area (FEBA) or it can penetrate in a fluid-combat situation if defenses are not prohibitive.

Data transmission systems with high capacity, more precise side looking radar, longer range I.R., should all take second priority to the definition of how collected data may be filtered at the source to cut down information that the forward area command has to sort and handle. The Mohawk with I.R., MTI, and Radar presentation all on board is a good system. The observer is the filter. He only uses one percent of what he collects but he uses it right now for fire di-



rection, identification or close air support call up.

Old concept systems, sound, flash, seismic may need to be revived for the Viet Nam type of problem (which may be our only real problem for the future). They have asked for a 360° mortar locator which ECOM is attempting to do by radar but my guess is that there may be a better solution. There is no doubt that this is a problem. We should also worry about how fast we can respond (and with what) if we locate a mortar.



Regarded ~~CONFIDENTIAL~~  
when separated from  
classified enclosures

- 37 -

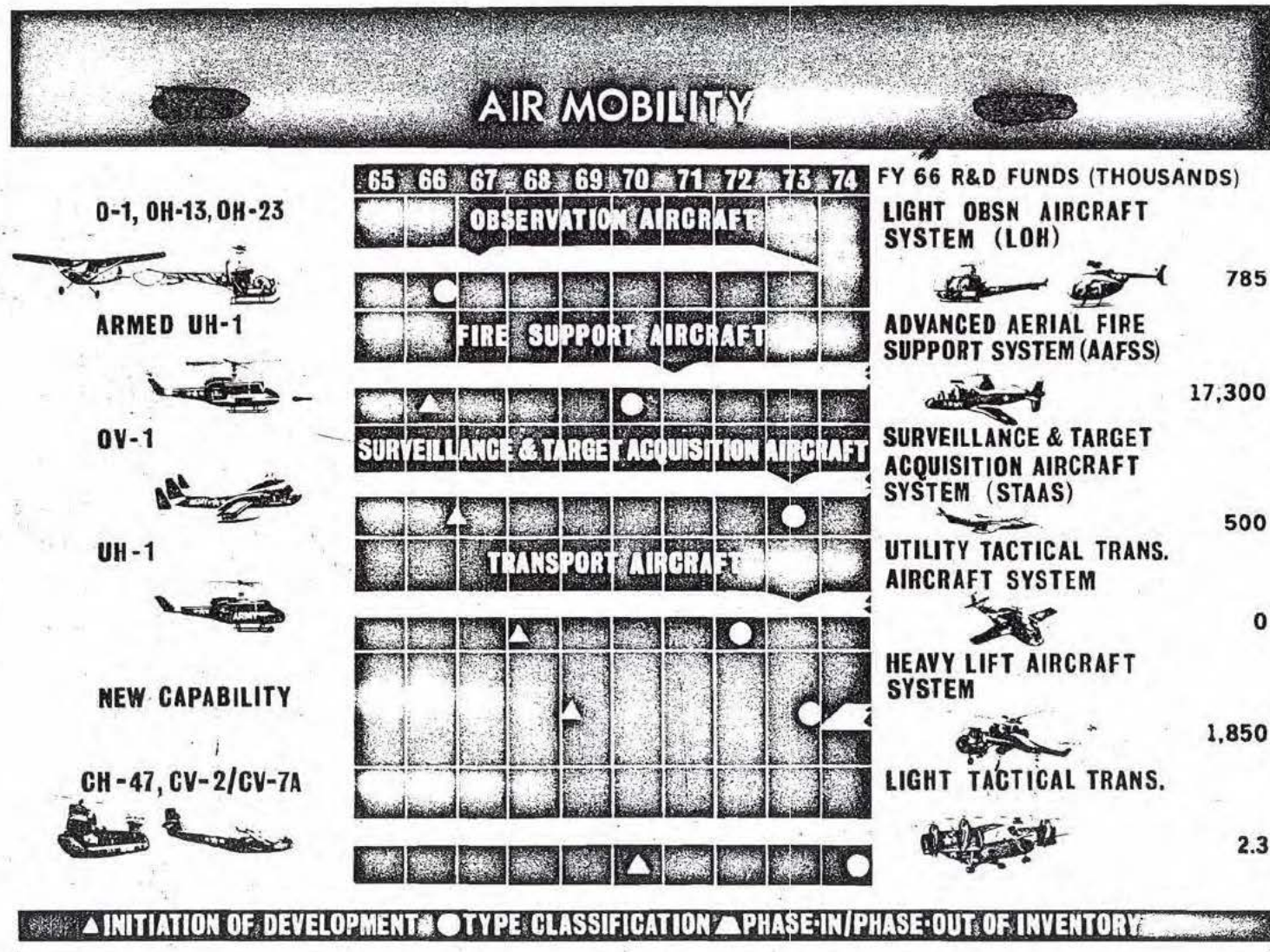


FIGURE IX

## Air Mobility

The Air Mobility diagram on the previous page does not reflect an up-to-date summary of what the Army program should be, in my opinion, and Charles Zimmerman, Chief Engineer of AMC, is currently trying to review our total program to see how it should be modified. Line for line here are my comments.

1. Light Observation Helicopter: After substantial pain we decided this one correctly. The LOH looks like a good program with only minor changes required for ten years.

2. The Armed Helicopter (AAFSS) now in early development was arrived at with an unusually logical analytical and thorough evaluation program. I had to drop out when Lockheed started to compete, but Charlie Poor knows almost every detail. My only philosophical worry is that the Army will try to buy many machines with maximum gear aboard and will price itself out of a mission. There should be several versions of AAFSS in production - a nearly bare one with tons of guns and ammunition - one with full all-weather accurate conventional fire power -



one configured for optimum night operations, maybe as a path finder for the simple version. This mix should be the result of a good analysis not a blind guess. Also there are potential reconnaissance and tank killer versions.

Prime problem in this field was whether to insert an interim ship (the Bell Cobra) into the inventory for immediate Viet Nam needs. This was justified since it was one to two years ahead of AAFSS and can save many lives. It was denied at DOD for a long time, but was finally accepted. The Army must now be certain that it achieves the maximum fire power version (with flexible armament) as soon as possible. The one gun turret is not enough and, therefore, every effort must be aimed at getting the two gun turrets in the field as soon as possible.

3. The Mohawk Follow-on (STAAS). I have already commented on this. It would be hard to improve on the Mohawk and I believe that a vertical-rising fast reconnaissance airplane (M-.9) is only a blatant slap at the Air Force. The Army needs, I'm guessing, a long duration multi-system (ELINT, MTI Radar, I.R.) patrol aircraft for behind-the-lines patrol looking across the Forward Edge of the Battle Area. Data should be correlated



on-board and only essential information transmitted to both low and high echelons of command. This system will be supplemented by (again, my own opinion) a very low altitude, (maybe helicopter) spot data collector which penetrates on command to get specific details. The patrol aircraft can also call on Air Force reconnaissance for specific penetration to get detail information.

4. The Follow-on UH-1D Squad Carrier will be a tough one to define and the present aircraft will be tough to beat. The only suggestions I have is that it might have two engines for improved survivability in a more hostile environment than present Viet Nam opposition. It might also be designed for exchangeable fuselages like the cranes. This would let the field commander have several special versions with common flying machinery. From a seniority standpoint this should be the next machine to develop. Present requirements are not well justified and there will need to be more work before a new program can be sold.

5. The Army had a requirement for a 20-ton heavy lift crane. Viet Nam plus the availability of the CH54 pushed



them into a smaller machine. I believe that this will delay (and should) any consideration of a new machine until these are wearing out -- five to ten years.

6. In the light transport field I think we have the biggest potential for a new profitable development. The Chinook - CV-7 combination was a well conceived team: VTOL, where needed, and transport efficiency when real estate is available for landing. The Air Force successfully destroyed this concept by blocking the purchase of the CV-7 which left the Army with only the Chinook. It is a good machine and should continue through normal product improvement. Its follow-on could be started now, however, and there is some backing in DDR&E for this (Dr. Cheatham). I think that the state-of-knowledge could give the Army a VTOL that will be efficient enough so that the fixed wing airplane could be eliminated without cost penalty from the transport tasks in the Army at ranges (radius) below 100 nautical miles. My candidate is the unloaded rotor compound but Charles Zimmerman would probably vote for a tilt rotor machine. This should precede a new squad carrier as the next aircraft development, in my opinion.



7. Not listed as a concept is the helicopter artillery combination. I don't know how best to approach this - a separate pill box installed and retrieved by helicopter - a rocket-firing fuselage that launches missiles only after landing - or a flying tank. This should be thoroughly explored but we will need to be mighty convincing to sell to either the Army or to the Office, Secretary of Defense (OSD).



# SURFACE MOBILITY

M 113 APC



M-113, M-114, MICV-65



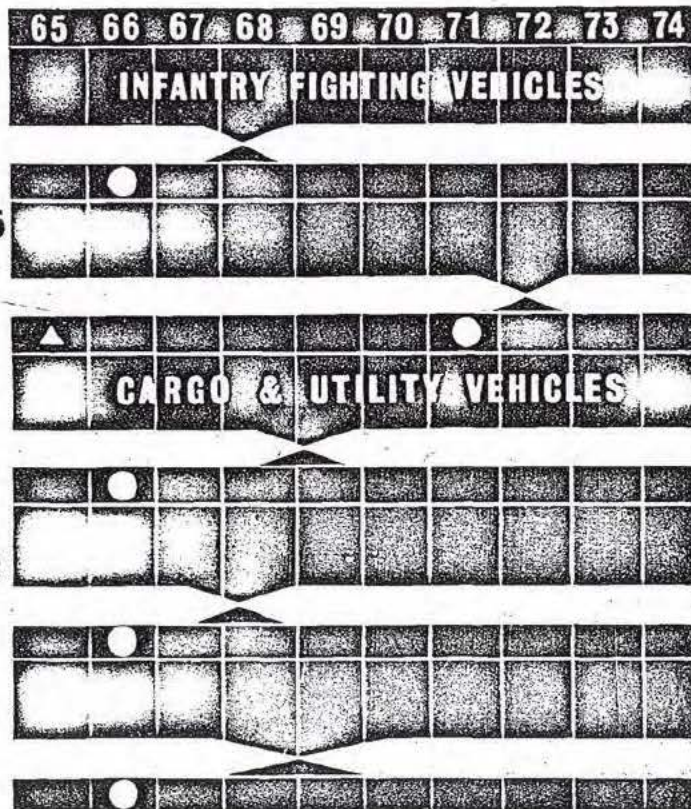
2 1/2, 5, 10 TON  
WHEELED VEHICLES



1/4 TON, MECH MULE  
& WEASEL FOR ARCTIC



1/4 TON W/TRAILER  
& 3/4 TON TRUCK



FY 66 R&D FUNDS (THOUSANDS)

MECH INF CBT VEH  
(MICV-65)



224

ARMORED INF FIGHTING  
VEHICLE (MICV/AIFV-70) 1,000

GOER (8 TON)



0

XM 571



20

XM 561  
GAMA GOAT



938

▲ INITIATION OF DEVELOPMENT ● TYPE CLASSIFICATION ▽ PHASE-IN/PHASE-OUT OF INVENTORY

FIGURE X



### Surface Mobility.

This area of endeavor has been one of the most frustrating for me because requirements have been written for improvements on almost every vehicle we own. And when we develop them nobody is willing to pay the price or didn't believe the requirements in the first place. The prime problem is that the requirements are written around the worst problems the Army will ever face - mud, sand, water, jungle, etc., (forgot snow and ice), and yet a standard commercial vehicle will do 90 percent of the transport jobs. Somehow the requirements must recognize that the Army can and should buy a mix of standard and "all problem" vehicles. Until then, there will be continuing problems in selling new developments.

The most promising new development is the MICV-70 which is now only starting. A study, hopefully as thorough as the Main Battle Tank analysis, has been started with Northrop. This should form a basis for a logical program. The Gama Goat, the 8-ton Goer, and the 10-ton truck have cleared the hurdle to Standard A. The XM-571 shows plenty of promise, but it hasn't made the grade and it looks like a prime target for special attention to get it over the hump.



Any ideas on how to make a new Jeep that is potentially cheaper would be gratefully received. (It will have to float, not tip over easily, be air-droppable and three-fourths the price.)

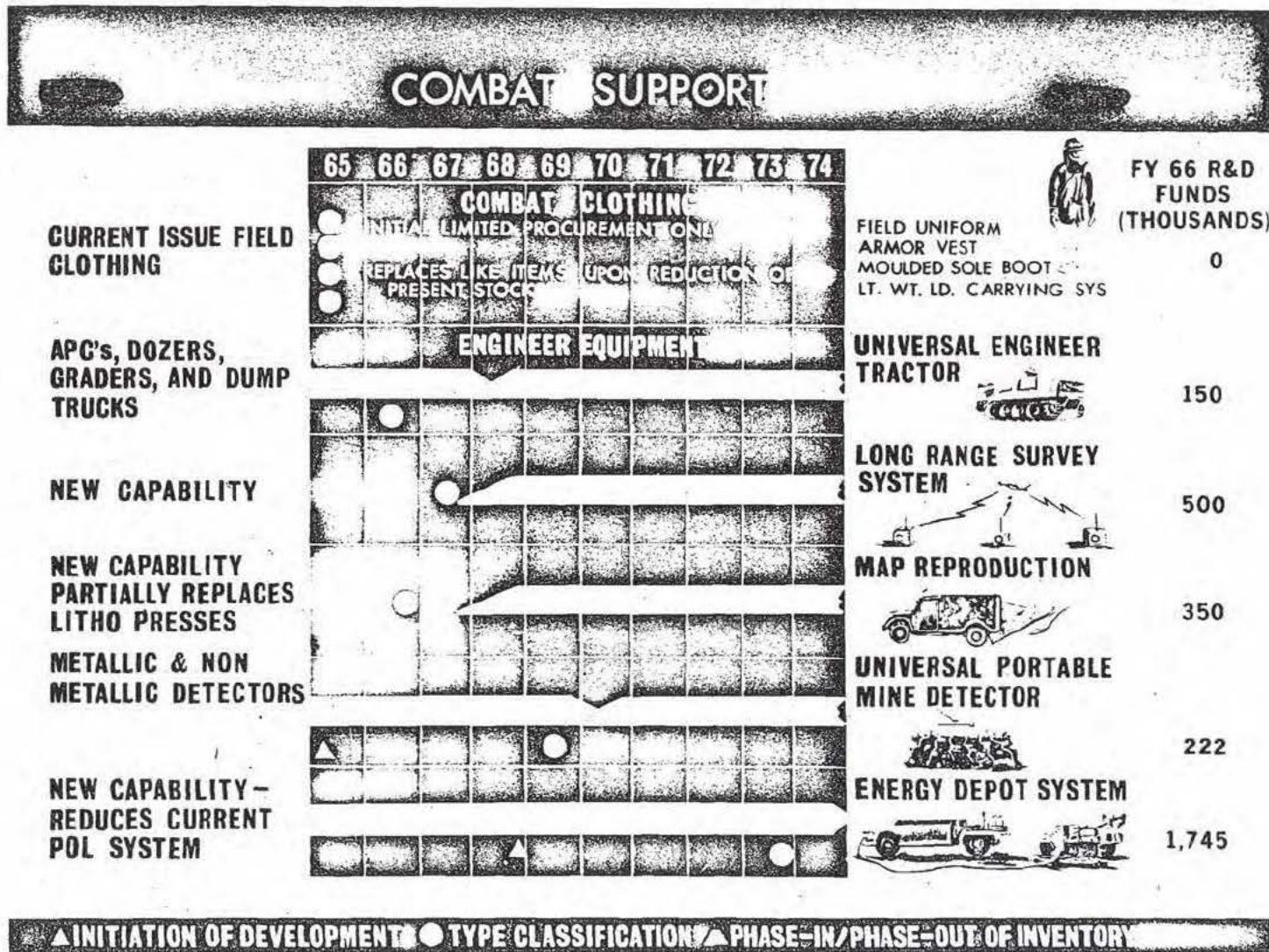


FIGURE XI





## Combat Support

The multiplicity of small programs that the Army is doing reasonably well will be surprising, I'm certain. My concern is that many of the developments are not absolutely necessary. There appears to be no other way, however, to retain some "looking forward" capability without retaining in-house development capabilities. These comments apply to the food, clothing, and shelter programs. It would be good to have some industrial competition, but there is none to challenge our creativeness in these fields.

Some line item comments are:

1. There must be some way to reduce the size and weight of engineer equipment or make it more effective when we get it there. This equipment is one of the prime causes for the tremendous size and payload capability of the C-5 airplane.

In the same vein it behooves the Army to make a major effort in the design of its maintenance and service trailers. I started a program, which died somewhere in the system, where we were to see what we could do about retractable wheels or collapsing roofs in order to reduce the volume of these trailers. Although their total weight is



relatively low the volumetric requirement constitutes another demand for outsize airplanes. We should be able to do something ingenious in this area.

2. Map-making in the field (and at home) has been so entrenched for so many years that it is a very strong union. I believe that their concepts are over-complicated and their operations over-facilitized. Further there is a major national conflict wherein the Air Force is attempting, and may be succeeding, in taking over the mission under the guise of making flight charts. I admit a sense of frustration for not having contributed more in this field.

3. Mine detection on a more effective scale is an important requirement that needs a good idea. All mine detection at the moment is limited to the velocity of a foot soldier who can sweep a path approximately six feet wide. Thus, the purpose of a mine field is fulfilled even though no casualties are suffered because any advance is only at a slow walking pace. Included in this area of technology is the problem of search - ships, etc. - to find contraband quickly. This, too, needs an idea.

4. The energy depot was an attempt to create a portable, or hopefully mobile reactor, which could provide the energy to create POL for vehicles from indigenous materials. Ammonia was decided on and both the reactor and generating gear were designed to generate ammonia. Modifications of interval combustion engines were conceived to permit running on ammonia. The reactor became expensive and massive and the engines required such extensive modifications that the idea rapidly became impractical. It has now been stopped except for final reports and it should be. It seems to me that we should continue to probe this general concept but at the moment I know of no idea worth pursuing.

5. Biological Warning Devices: Our efforts to develop biological agents have been so successful in both the lethal and incapacitating fields that we must consider the very serious consequences of having them used against us. The trace densities of some of the agents are so slight, however, that one can easily be discouraged in attempting warning device development. I know we must continue to work in the area but I have very poor knowledge and less of



an opinion on the adequacy and importance of the program. This area probably needs an outside careful review, perhaps by the ASAP.

6. Night Vision: This area has been brilliantly handled by Dr. Wiseman and his staff at the Engineer Research and Development Laboratory (ERDL). This performance led us to promote him to head the Reconnaissance Laboratory (which now contains the Night Vision Laboratory as an element) at Fort Monmouth. The application of our second generation devices and production of the third generation must be pushed. The proper combination of night vision devices, including television scanning from helicopters, has so much promise that we need to push it very hard. The companion effort on infrared imaging should also be accelerated. I. R. Scanning to help point low light level passive scopes seems to me to be a very powerful concept. It should be supported enthusiastically along with the low light level television for helicopters. One idea which may have been neglected is the use of non-visible or obscurely visible light sources to assist definition and permit longer range utility of low light level devices. The Night Vision Laboratory

at ERDL has a new night vision simulator they want to build and I would support it wholeheartedly.

7. Kitchen Equipment: We have, for many years I'm told somewhat facetiously, depended on swiping Field Kitchens from the British since they have a good one and are usually fighting with us. Our new food packaging and preparation methods suggest that we should try for a very good Field Kitchen. Our In-House Laboratory Fund has created a concept at Natick which could probably be nurtured and I recommend that a progress report be requested to see if their idea is ready for more accelerated development.



# SATELLITES AND SPACE

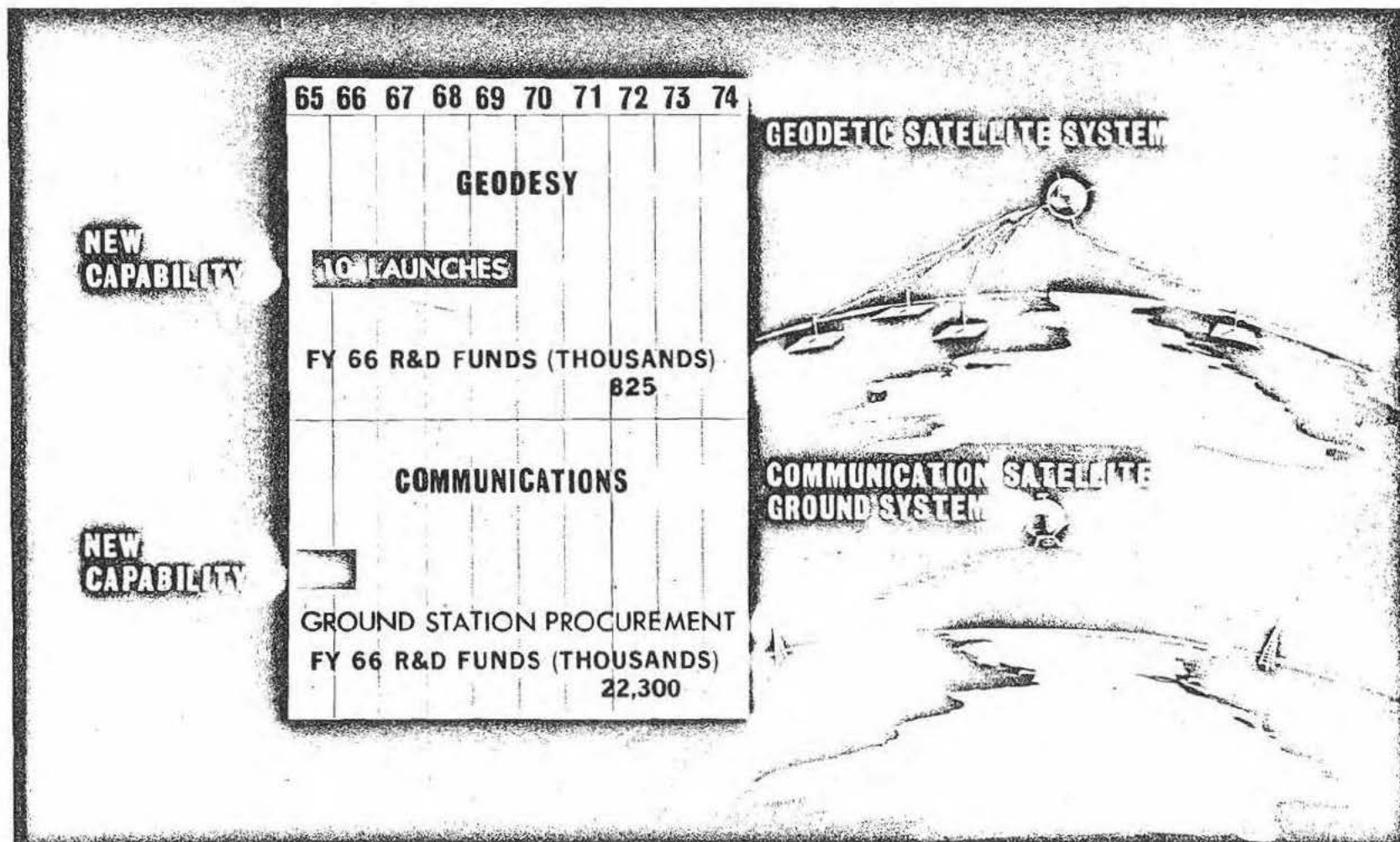


FIGURE XIII

This program has dwindled from Army command of the whole program to Air Force command of the airborne part with Army only supporting with ground stations. This work is very nearly complete and on the ground station work we have done reasonably well. However, there are many pressures that will tend to change the development pattern in the future.

1. Air Force facilities for space tracking and command will dominate any Military Communications System. This plus the Lincoln and Cambridge Labs will put the Air Force in a commanding position even for ground stations in a Military Communications System.

2. Current efforts to make compatible, and eventually common, Tactical C<sup>3</sup> Systems (Command, Control and Communications) for joint operations will also favor the Air Force. This is beginning in the assignment to the Air Force of the chairmanship of the Joint Tactical C<sup>3</sup> Service Organization (JSO) in DDR&E. This was resisted by Navy and Army but even if watered down the Air Force is in charge. Although not aimed specifically at tactical Satellite Communications Systems it will cover them logically.



My recommendation is to resist this tendency as much as possible, but our talent at the Electronics Command suffers in comparison to Cambridge and Lincoln. Thus, until we have a major rejuvenation at ECOM in Communication and Radar technology, we will be on the defensive.

The low level geodetic work to make possible spot locations anywhere in the world is probably good and is being well done. This can and should continue.

# AMMUNITION DEVELOPMENT

## SMALL CALIBER



CURRENT  
ITEM

WEAPON SYSTEM

NEW ITEM

STATUS

NONE	M14 RIFLE & M73MG (7.62MM)	CART, CASELESS	PROTOTYPE - PRINCIPLE APPLIES STAGE TO OTHER AMMO
NONE	M16 RIFLE & AR (5.56MM)	CART., BALL M193 & TRACER XM196	SERVICE - LIGHTER WEIGHT EVALUATION SYSTEM
7.62 CTG. BALL M80/40MM M406	SPIW (5.6/40MM)	CART. 5.6 MM BALL/ 40MM M406	3 WEAPON - POINT & AREA CANDIDATES TARGETS

## MORTAR



CART. 4.2" HE M329A1	XM95 MORTAR (107MM)	CART., HE, XM462E1	EXPLORATORY - INCREASED RANGE DEVELOP
NONE	XM95 MORTAR (107MM)	CART. HE ROCKET ASSIST, XM516	EXPLORATORY - ADD. RANGE; DEVELOP LESS WEAR
NONE	XM95 MORTAR (107MM)	CART. GB, XM498	ENGR. DESIGN - NON PERSIST. AGENT
NONE	XM95 MORTAR (107MM)	CART., VX, XM499	ENGR. DESIGN - PERSIST. AGENT

FIGURE XIV



# AMMUNITION DEVELOPMENT

## MINES



CURRENT  
ITEM

WEAPON  
SYSTEM

NEW ITEM

STATUS

NONE

DISPENSER, A/P  
MINE, XM73

MINE, A/P, XM27

ENGR. DESIGN - EXPEDITED DEVELOPMENT  
TO MEET POSSIBLE RVN REQUIREMENT

NONE

N/A

MINE, A/T, XM24

ENGR. TEST/ - DISCRIMINATING TARGET  
SERV. TEST "OFF-ROUTE" SYSTEM

## SPECIAL WAREFARE



M173 PROJECTED  
LINE CHARGE  
NONE

N/A

N/A

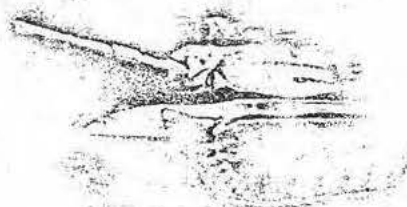
DEM-KIT, PROJECTED  
CHARGE, XM127  
FIRING DEVICE,  
DEMOLITION, XM63

ENGR. TEST/ - CLEARS 16'x300' PATH  
SERV. TEST  
ENGR. DESIGN - 1600M REMOTE FIRING

FIGURE XV

# AMMUNITION DEVELOPMENT

TANK



CURRENT  
ITEM

WEAPON SYSTEM

NEW ITEM

STATUS

NONE	M68 GUN (105MM) FOR M60 TANK	CART., A/P, XM494E1 [BEEHIVE]	ENGR. DESIGN - CLOSE-IN DEFENSE
CASE, CART. [STEEL], M148A1B1	M68 GUN (105MM) FOR M60 TANK	CASE, CART. [CONSUMABLE], XM181	ENGR. DESIGN - FOR M456 HEAT ROUND
CASE, CART. [STEEL], M150B1	M68 GUN (105MM) FOR M60 TANK	CASE, CART. [CONSUMABLE], XM182	ENGR. TEST/ - FOR M393 SERV. TEST HEP ROUND
NONE	XM81 GUN/LAUN [152MM] FOR XM551	CART. HEAT-MP [COMBUSTIBLE], XM409	ENGR. TEST/ - AT, AP, SERV. TEST MATERIEL
NONE	XM81 GUN/LAUN [152MM] FOR XM551	GM, A/T, XMGM-51A	ENGR. DESIGN - HIGH 1st ROUND KILL

FIGURE XVI



# AMMUNITION DEVELOPMENT


## AIRCRAFT

CURRENT ITEM	WEAPON SYSTEM	NEW ITEM	STATUS
2.75" AERIAL ROCKET	UH1B W/XM3 ARM. SYSTEM	XM151 WARHEAD	ET/ST (W'HEAD) - INCREASED EFFECT
NONE	XM30 ARM. SUB-SYSTEM FOR HELICOPTER	CART. 30MM HEAT, XM552	ENGR. DESIGN - DUAL A/P A/MATERIEL
NONE	M5 GRENADE LAUNCHER (40MM)	CART. HEAT, XM429, 40MM	ENGR. TEST/ SERV. TEST - SHAPED CHARGE, A/P, A/T

## 105mm ARTILLERY

CART. HE, M1 & M482	M2A2 & M102 HOW (105MM)	CART., HE, ROCKET ASSIST, XM 548	ENGR. DESIGN - INCREASED RANGE
NONE	M2A2 & M102 HOW (105MM)	CART., HEAT, XM461	ENGR. TEST - TO PROVIDE A/T CAPABILITY
NONE	M2A2 & M102 HOW (105MM)	CART., A/P, XM546 (BEEHIVE)	ENGR. DESIGN - FLECHETTE LOADED

FIGURE XVII

<div> <div>AMMUNITION DEVELOPMENT</div> <div>175mm ARTILLERY</div>  </div>			
CURRENT ITEM	WEAPON SYSTEM	NEW ITEM	STATUS
NONE	M107 SP GUN (175MM)	PROJ. HE, XM403, 175MM	ENGR. TEST - COFRAM SERV. TEST
NONE	M107 SP GUN (175MM)	PROJ. HE, XM484, 175MM	ENGR. DESIGN - COFRAM
NONE	M110 SP HOW (8in)	PROJ. HE, XM509, 8in	ENGR. DESIGN - COFRAM


<div> <div>155mm ARTILLERY</div>  </div>			
NONE	M109 SP & XM138 LT. WT. SP HOW	PROJ. HE, BOOSTED, XM549	ENGR. DESIGN - ADD. LETHALITY & RANGE
NONE	M109 SP & XM138 LT. WT. SP HOW	PROJ. HE, XM483	ENGR. DESIGN - COFRAM
PROJ. HE M449E2	M109 SP & XM138 LT. WT. SP HOW	PROJ. HE, XM541	ENGR. DESIGN - COFRAM

FIGURE XVIII



## Ammunition Development

I find in reviewing my experience in this field that I have developed the impression of dealing with a group of extremely capable craftsmen in a most isolated technical area. They have the confidence of long superiority in a field where no peers develop competitively and one is left with the feeling that, clever as many of the concepts are, we may not be getting really good ideas but rather warmed over concepts from an inbred group of creators for which there is no standard of performance. I emphasize that this is only an impression, but I propose to list more detail impressions that may suggest areas for a more thorough study than I have made.

1. We have more projects on ammunition than one can keep track of. Once a caliber is determined a whole host of ammunition types is "automatically" developed for it. Most of these efforts seem to come into being without specific requirements.

2. Although techniques are cross-correlated among ammunition types, very few common pieces of hardware are used, for instance, 40mm grenades for shoulder-fired and helicopter turret use. These shouldn't be identical but certainly many elements could be common and they aren't.

3. Basic concepts affecting all ammo are not

pursued on an overall basis but rather on specific ammo items: Combustible cases, strategic materials in shells, etc.

4. Effectiveness of ammo is not broadly analyzed and reanalyzed. Testing of hundreds of rounds appears to be real basis for performance rather than controlled testing plus analysis. (Note necessity for current "after-the-fact" COFRAM test program.)

Comments on specific programs are as follows:

1. Small caliber: SPIW flechette concepts and case-less small arms appear to me to be programs for major emphasis. However, the "short range" character of our Viet Nam experience suggests that we need a low recoil (like pistol) with expanded area lethality (like SPIW flechette) and there is no reasonable program in this area.

2. Mortar rounds: There are many more calibers of mortars than shown on this chart but the proliferation of ammo types for the 107mm illustrates the multiple project type of approach that was previously emphasized. I'm not sure that all types of ammo are needed for every caliber -- or for that matter, I'm not sure that we need as many calibers? It has also occurred to me that finned - and boosted-rounds make sense for mortars and perhaps a D. C. (or D. C. automet)



guidance round.

3. Mines and Special Warfare: With the advent of night vision helicopters it seems to me that the precise sowing of aerial emplaced mines assumes major importance as an offensive weapon. The gravel mine may be a first step with the trip wire coming next. We need some creative "tactic" thoughts in this area and then some overall systems development. In this field there is one entirely new concept which I have asked to be reviewed (K. C. Emerson). This is the concept of a mine (like the DRAGONTOOTH) which contains an incapacitant or corrosive liquid or gas and which does not emit a strong signal when stepped on or driven over. The purpose here is to effect mass casualties since the first man or vehicle does not warn the remainder that a mine field is being penetrated. The obvious use for such a device is again at night where barriers are desired as against supply or manpower trails to Viet Nam.

4. Large Caliber Rounds: The Army has embarked on quite a simplification of its calibers concentrating on the 155mm gun. This is good and should be pursued. However, its success is dependent on obtaining a good 30,000 yard boosted shell, hopefully nuclear. With this in inventory the

Army can retire the 175mm gun and should. (LANCE can also help the demise of this awkward weapon.) Caseless ammo in the short range versions of the 155 could also be pushed. The 152mm companion rounds for the SHERIDAN, MBT-70 and M60 A1E1 have demonstrated difficulties with moisture absorption at this very late date (black mark for Picatinny Arsenal it seems to me). This should be followed very closely along with the development of the MBT high velocity discarding sabot round. This latter round is still too inaccurate (.60 mil) and must be brought down to .25 mil if it is to be accepted without question. Hopefully, since our June demonstration to FRG we have convinced them that this is the proper solution. If so, we must go to work and finish the task. Main criticism here is that Picatinny is not using the talent at the Ballistics Research Laboratory (BRL) (theoretical) to help them define the source of their inaccuracies -- all cooks and no science.

5. Aerial Fired Rockets: The 2.75" folding fin rocket is our standard hard punch weapon for helicopters. It is old and was developed for reasonably high speed airplanes. Its fuse sets it off deep in the mud at times and, in general, it seems logical that we could do better. It is my opinion that a



good BRL study (or contract) may put us into a development that could cut the weight and cost of this round in half. Nothing has been started on this one.

The fuse has been worked on and we should brag about the job HDL did on short notice. We should get the new fuse into production immediately.

# ARMY RESEARCH PROGRAM

## BASIC RESEARCH (6.11)

FY 66 \$ (MILLIONS)

IN HOUSE LABS

10.2

NIGHT VISION

3.9

MATERIALS

6.1

TERMINAL BALLISTICS

2.8

COMMUNICABLE DISEASE  
IMMUNOLOGY

5.5

## APPLIED RESEARCH (6.21)

FREQUENCY COMPATIBILITY

3.1

AVIONICS TECHNOLOGY

4.2

AIRBORNE SURV/TGT ACQ

7.0

MISSILE GUIDANCE/  
CONTROL

3.3

LIMITED WAR LAB

4.5

FIGURE XIX



# FUNCTIONAL AREAS OF R & D

FY 65 R&D FUNDING (MILLIONS)

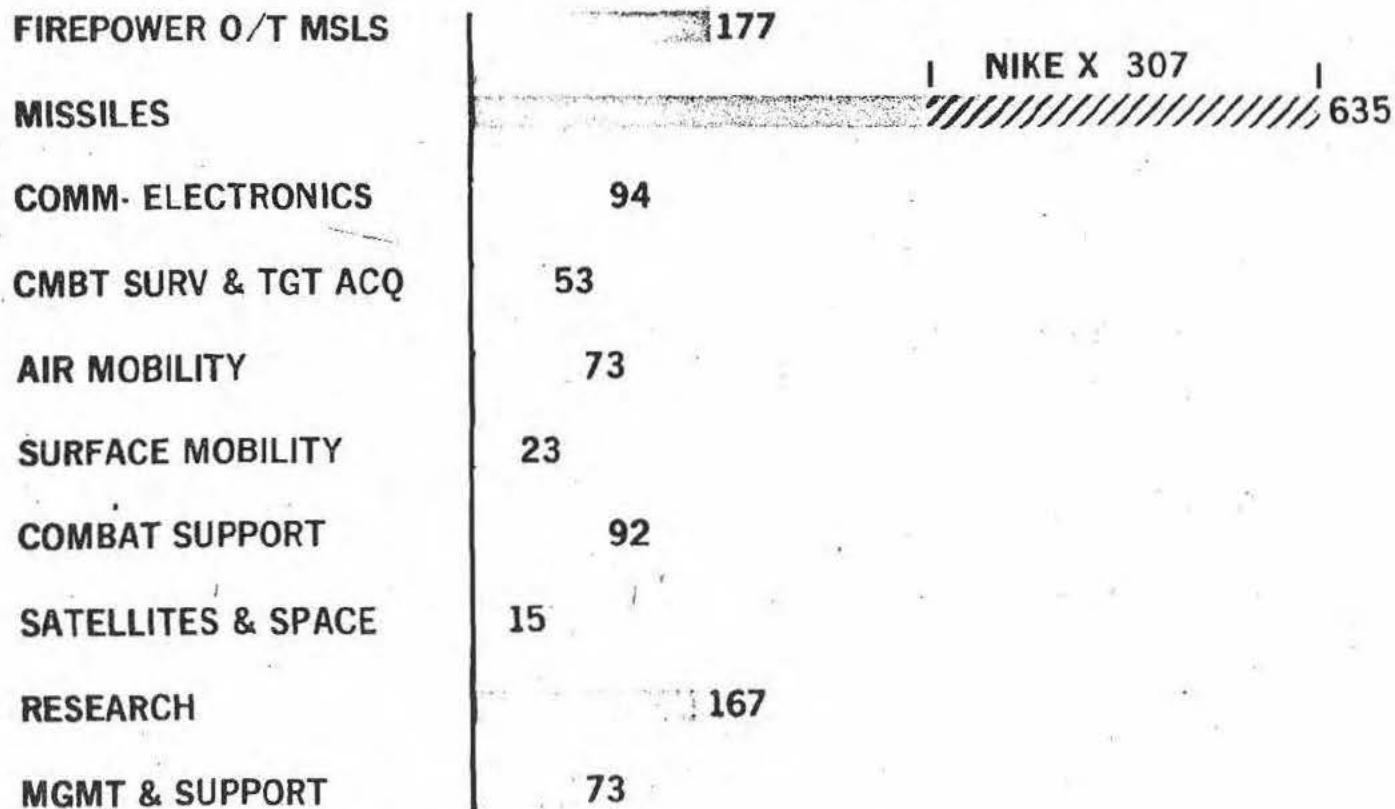


FIGURE XX

### Summary

The previous two charts show our Research Program and a comparison of the R&D expenditures in the major functional areas. The purpose of the charts was to get a broad impression of relative financial emphasis.

Regarding Research, I have no specific suggestion except to say that the combination of K. C. Emerson, in this office, General Betts, CRD, and Dr. Thomas, General Philbin, and Dr. Siu at AMC are all working well together. The change in organization by General Besson to create Dr. Thomas' position and the way in which he has joined the team are both major accomplishments and you will find that, as a result, the Research programs are quite well handled.

On the Development chart the expenditures for Ground Mobility, and Combat Surveillance and Target Acquisition seem relatively low. For areas of such signal importance to the Army there should be more creative vision and there should be an energetic follow up with active developments.

Finally, it appears that, try as we will, neither DDR&E nor the Office of the Assistant Secretary of Defense for Systems Analysis accepts analysis results or judgments from the Army.



Therefore, anything that is done must be done with their participation and probably their specific direction on assumptions, methods, etc. This is hard to take when a large percentage of the time the Army can create equally logical assumptions and has learned to use rational analysis methods. Nevertheless, if the Army can swallow its pride and actually solicit this participation in the very early stages of any program, it will save years later on and may save many useful programs from very powerful opposition.